



Visioning of the Coral Sea Marine Park 30-day Post Cruise Report

Ship name: Falkor

Cruise Dates - Day Departed: 04/29/2020 **Day Returned:** 06/12/2020

Cruise Number: FK20429

Departure Port: Cairns, Australia **Arrival Port:** Cairns, Australia

Mid-Cruise Port Call (if any): Cairns, Australia

Participating Organizations, Institutions, Foundations, Government Agencies, etc. James Cook University (www.jcu.edu.au), The University of Sydney (<https://www.sydney.edu.au>), Geoscience Australia (<http://www.ga.gov.au>), Queensland Museum (<https://www.qm.wld.gov.au>), Museum of Tropical Queensland (<https://mtq.qm.qld.gov.au>), Biopixel (<https://biopixel.tv>), Coral Sea Foundation (<http://www.coralseafoundation.net>), Parks Australia (<https://parksaustralia.gov.au>).

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Name of Chief Scientist: Dr. Robin Beaman

Organization: College of Science & Engineering, James Cook University

Country: Australia

Phone: +61 7 42321693

Email: robin.beaman@jcu.edu.au

Name of Co - Chief Scientist: Jody Webster

Organization: School of Geosciences, The University of Sydney

Country: Australia

Email:

Cruise Objectives and Importance of this work:

The objectives of the cruise were to conduct multibeam surveys of the steeper flanks of the ~30 emergent reefs, and areas of submerged pinnacles and incised channels of the Queensland Plateau. The aim was to map as high up the steeper flanks as was navigationally safe, to prove the existence of any possible wave-cut caves that might indicate LGM lowstand, similar to LGM lowstand-generated features on the adjacent Great Barrier Reef (GBR) and to reveal the detail

of the deeper flanks, such as canyons and landslides.

Another goal was to conduct long vertical ROV transects at representative reefs to understand whether spatial patterns of benthic assemblages across large depth gradients are similar at the regional-scale across the Queensland Plateau, compared to previous observations at Osprey Reef, and to reveal mesophotic coral ecosystem trends in shallower parts.

The information from this project is crucial for helping to understand the geological evolution of the reefs of the Queensland Plateau, and for developing insight into the distribution of deeper reef habitats and biodiversity patterns in the Coral Sea Marine Park.

Description of geographical area where the science occurred and why this location was important

The project focused on the Queensland Plateau through geophysical mapping and ROV imaging the steep flanks of the ~30 large coral reefs that lie across the plateau, including areas of possible clusters of drowned reefs, and several low-relief channels incised into the plateau surface.

The Queensland Plateau, lying within Australia's Coral Sea Marine Park, is one of the world's largest continental margin plateaus. With an area of ~280,000 km², the Queensland Plateau is a submerged carbonate platform comparable in size to the Bahama Banks in the Northern Hemisphere. The plateau is bounded to the west by the 1200-2800 m deep Queensland Trough and to the south by the 1200-2400 m deep Townsville Trough, which separates the plateau from the adjacent Great Barrier Reef. The plateau is bounded along the northeastern side by the 4000-4800 m deep Coral Sea Basin.

This submerged carbonate platform when the Coral Sea Basin opened in the Palaeocene about 60 Ma splitting off fragments of continental lithosphere. Subsidence and drowning commencing in the Middle to Late Eocene (42 – 37.5 Ma) led to its present median depth of about ~1100 m. The plateau now supports ~30 emergent and submerged reefs growing on the corners of these basement high points. The emergent reefs include large atoll and banks (over 90km long) and smaller pinnacles (km to 100 m wide) with shallow coral reef occupying almost 15 percent of the surface of the plateau, with reef growth commencing when the Australian plate moved into the tropics in the Early Miocene (~22Ma).

Very limited multibeam bathymetry data existed on the Queensland Plateau either across the broader platform surface or around the steeper flanks of these ~30 emergent reefs. While all these shallow reefs have airborne lidar bathymetry over them to ~50m depth for safety of navigation purposes, the deep plateau has only ever been systematically mapped using widely-spaced, singlebeam echosounder lines. Hence, very little seabed morphological data

exited for the plateau itself, nor around the steeper flanks of the reefs, which could reveal the features (notches, terraces, drowned reefs, slump scarps, mesophotic reef habitats, etc.) typically found on well-mapped oceanic reefs in other parts of the world.

Similar to the lack of multibeam mapping, very little was known of the deep marine life of the Queensland Plateau. In contrast, the shallow-water coral reefs have been well surveyed through Australia's NESP Marine Biodiversity Hub and other scuba surveys. Mesophotic coral ecosystems have also been relatively well studied to ~125 m depth using shallow ROVs/AUVs. Several benthic sled surveys took place during the CIDARIS voyages in 1986 near Flinders Reef at ~1000 m. However, the only deep-sea ROV survey conducted was to ~800 m by the German Deep Downunder expedition in 2009 to Osprey Reef.

Therefore, only a comprehensive multibeam survey around these 30 reefs and the other enigmatic features of the Queensland Plateau could reveal their true morphological detail. Further, long vertical ROV SuBastian transects at these reefs will help understand whether the depth versus benthos trends are regionally similar across the Queensland Plateau.

Impact of the Research:

- 35,554 square kilometers of seafloor mapped with high-resolution multibeam depth data
- New map data around all 30 of the large coral atolls and banks found on the Queensland Plateau. Depths mapped range from 80 m to 2800 m.
- Complex seafloor revealed, including submarine canyons, dune fields, submerged reefs, underwater landslides, and huge debris blocks scattered around periphery of the reefs.
- ROV vision over undersea landslide scarps show internal strata layers of these ancient reefs. No evidence of mass bleaching in the corals observed with the mesophotic zone to ~80 m.
- Wide variety of mesophotic reef habitats, with very different ecological communities between steeper gradient upper flanks compared to more gentle gradient slopes.
- Deepest records of living hard corals for Australia to 149 m within the mesophotic zone.
- First time the more gently sloping habitats examined in the mesophotic zones and found prolific *Leptoseris* (deep hard coral genus) fields.
- Better understanding of the depth trends and habitat preferences of the deeper coldwater coral communities and shallower mesophotic coral ecosystems of the Coral Sea reefs.

Information Sharing with Managers and Local Communities

This project addresses a range of priorities of the Australian Government in terms of mapping and characterizing a poorly known frontier area of the Australian marine estate.

The seabed mapping of reefs and seamounts in the Coral Sea Marine Park is a high priority for Parks Australia, the managers of Australia's Commonwealth Marine Parks. The new multibeam

data acquired will be added to the national bathymetry database hosted by Geoscience Australia and released through the AusSeabed Data Portal.

Information from the ROV imagery, such as new species or range extensions, will be added to the living resources databases managed by the Australian Government and made publically available. Parks Australia will utilize the derived information to communicate the important environmental values of the Coral Sea Marine Park to the broader community.

The information from this research is likely to be of great interest to the general public, who were widely consulted on the zoning and activities prior to the nearly 1 million square km Coral Sea Marine Park being declared in 2017 – the largest Marine Park in Australia.

Having 4K-resolution underwater video imagery of the deeper reef environments of the Coral Sea, allows us to tell the full story of the interconnected environments of the Coral Sea. This vision is invaluable for educational, social and mainstream media platforms.

Suspected or confirmed new species discovered during the cruise

Fish

- First live imagery of several previously enigmatic fish species, particularly from the genera *Plectranthias* (Fairy Basslets), *Tosanoides* (Fairy Basslets), *Grammatonotus* (Groppo).
- New significant range extensions for fishes in the genus *Odontanthias* (Fairy Basslets), *Hollardia* (Spike Fish), *Bodianus* (Hogfish), *Roa* (Butterflyfish).
- Potential new species of *Grammatonotus* (Groppo), *Chromis* (Damselfish), *Pseudanthias* (Fairy Basslets), *Plectranthias* (Fairy Basslets), several recorded for the first time.
- Potential new genus of anthiadine serranid (tentatively identified as *Odontanthias* or *Dactylanthias*) (Fairy Basslets).
- Potential new wrasse, from the genus *Oxycheilinus* (Wrasses).

Sharks

- First in situ sightings of obscure catshark genus *Parmaturus* and on another dive, a swellshark.

Molluscs

Possible new species of slit snail, but certainly the first confirmed living in the Coral Sea. Chambered nautilus observed on nearly all ROV dives across the Queensland Plateau, indicating this cephalopod animal is common on all reefs.

Did you deploy and/or recover any Moorings, Bottom Mounted Gear, or Drifting Systems? No

Equipment Used & New Technologies tested: none

Total number of CTD casts completed during the cruise: 0

Total number of AUV dives completed during the cruise: 0

Total number of ROV dives completed during the cruise: 14 (totaling 91 hours: 21 mins:38 secs)

Total number of ROV samples collected during the cruise: 0

Total number of Unmanned Aerial Vehicle (UAV) or other vehicle deployments during the cruise: 0

Other notable facts about the cruise:

- Four (4) new drowned reefs (cone-shaped with heights up to 600 m above surrounding plateau surface) were discovered. These are significant features of the plateau and will need to be given names.
- Two (2) very long (>30 km distance) deep plateau channels were mapped, likely draining finer sediments from the plateau to the adjacent deep basins.
- All reefs showed signs of extensive undersea landslides with vast debris fields of limestone rock scattered around their periphery and lying on the deeper plateau surface. All indications are that these are ancient landslides (nothing recent).

Summary of Operations and Data Collection:

Wednesday 29 April 2020

Wind 3 kn from 150°. Sea state 1. Nil swell.

0800 in position 16.823199°S 145.851310°E anchored at Cairns Harbour.

At 0800, *Falkor* left its anchor position and headed into Cairns Harbour for reprovisioning and refuelling at Cairns Wharf. At 1500, Dr. Rob Beaman visited the ship briefly to meet with the crew before sailing, with appropriate social distancing due to COVID-19 restrictions. At 1600, the vessel departed Cairns to commence Voyage FK200429. *Falkor* transited through Grafton Passage across the Great Barrier Reef (GBR) shelf and then turned northward towards the first Plateau cliff survey area. The EM302 multibeam was turned on after entering the Coral Sea Marine Park to collect new multibeam data on the transit.

Thursday 30 April 2020

Wind 12 kn from 120°. Sea state 3. Low swell.

0800 in position 14.503716°S 146.326232°E in vicinity of Plateau ridge survey area.

Falkor continued transiting northward through the night towards the Plateau ridge survey area. This survey target had already had some multibeam data collected across it from the previous Torres Strait - Cairns transit during voyage FK200409, so additional multibeam data were collected on the eastern side of the ridge. On completion, *Falkor* headed northeast towards the northern tip of Osprey Reef.

Friday 01 May 2020

Wind 12 kn from 130°. Sea state 3. Low swell.

0800 in position 13.984582°S 146.729155°E at the southeast corner of Osprey Reef.

Overnight the ship continued mapping around the northern and western side of Osprey Reef on the deeper flanks. During daylight hours, the ship mapped higher up the flanks towards the shallower reef around the eastern and southern side of Osprey Reef. At 1400, ROV SuBastian was lowered into the water at the southwestern corner of Osprey Reef for ROV dive #354. Target depth was 1564 m with a ~ 4-hour dive up to ~1000 m for a vertical transect up a steep cliff. This was the first test of the shoreside communications with Dr. Rob Beaman providing commentary through Rendezvous-Wirecast software. The broadcast seemed to go well, with

some highlights being the stalked crinoids, pygmy dumbo octopus and coldwater corals. The ROV was recovered around 1800 and *Falkor* commenced multibeam mapping through the night within the Osprey Reef survey area.

Saturday 02 May 2020

Wind 16 kn from 130°. Sea state 4. Low swell.

0800 in position 13.819541°S 146.553568°E at North Horn, Osprey Reef.

Falkor had completed much of the deeper flank mapping around Osprey Reef overnight including one pass around Shark and Vema Reefs. A large underwater landslide and debris boulders revealed a flank collapse of the Shark and Vema Reefs. The ship then transited towards North Horn at the very northwestern tip of Osprey Reef. At 0930, ROV SuBastian was launched with a live broadcast from ~1015 as ROV dive #355. The target was 1011 m at the base of a steep ridge and to generally follow the 2009 German Deep Downunder ROV transect up the ridge. The live broadcast went well but some lag was noticed between the timing of the video and the audio from shore. Highlights were the numerous nautilus bobbing around the ROV, over 15 counted, between ~700-500 m. We also saw the transition from coldwater communities to warmer mesophotic communities around ~500-400 m. The ROV was recovered at 1600 and the vessel commenced surveying the shallower flanks while in daylight.

Sunday 03 May 2020

Wind 16 kn from 115°. Sea state 4. Low swell.

0800 in position 13.926814°S 146.477337°E on west side of Shark and Vema Reefs.

The ship continued mapping through the night as the wind picked up. A second pass around Shark and Vema Reefs mapped the deeper parts of these reefs where the plateau flattens out. Through the morning with daylight, the vessel mapped the shallower flanks on the western side of Osprey Reef then turned southward again to map the deeper flanks of Osprey Reef. Through the afternoon, the shallower sides of Shark and Vema Reefs were mapped. These two elongate reefs were clearly once joined, with a low ridge stretching between them, separating the shallower reef tops. These two reefs are separate structures from Osprey Reef to the north, i.e. a deep trough lies between Osprey Reef and closest Shark Reef. At 1900, *Falkor* completed the Osprey Reef survey area and commenced transit southward towards the Bougainville Reef survey area.

Monday 04 May 2020

Wind 25 kn from 120°. Sea state 4. Moderate swell.

0800 in position 15.64370°S 147.06560°E in vicinity of Bougainville Reef.

Falkor continued its southerly track towards Bougainville Reef approx. 6 hours away. Rough seas slowed progress but multibeam mapping continued along the north-western side of the Queensland Plateau in depths 1700 to 1400 m, rising slowly towards Bougainville Reef. The vessel arrived in the morning and commenced a slow loop around the unmapped portions of Bougainville Reef. By 0800, the Bougainville Reef survey was completed and transit commenced towards the Cairns Seamount about 5 hours away. At 1500, *Falkor* arrived at the Cairns Seamount survey area and commenced a lap around the flanks of this small reef. Base depths are ~1300 with a relatively smooth eastern side.

Tuesday 05 May 2020

Wind 21 kn from 140°. Sea state 4. Low swell.

0800 in position 16.433116°S 147.80148°E in vicinity of Holmes Reefs.

Falkor completed mapping around the Cairns Seamount revealing an almost conical bank topped with a small (few 100s m wide) shallow coral reef. The ship then commenced transit towards Holmes Reefs, about 230 km east of Cairns. Through the morning, a wide pass was made around both reefs, which established the extent of the deeper drainage channels. From midday, a clockwise pass was conducted between the two reefs, then two shallower passes around West Holmes Reef to survey as high up on the flanks as possible.

Wednesday 06 May 2020

Wind 24 kn from 120°. Sea state 4-5. Low swell.

0800 in position 16.474130°S 147.950151°E in vicinity of Holmes Reefs.

With the wind still high, *Falkor* had to plan mapping away from the shallower edges of reefs. A transit was made around Flora Reef, about 1 hour away from the Holmes Reefs, then *Falkor* continued back to map the East Holmes Reef. Through the daylight hours, shallow mapping was done around the lee side of East Holmes Reef getting as close as possible to the reef. The multibeam backscatter shows high reflectance on the upper flanks, as expected, where mesophotic corals and harder substrate would be present. Down the flank, reflectance

becomes lower as softer sediment drapes the lower slopes. The squally weather still restricted windward mapping of reefs so from 1400, *Falkor* moved behind West Holmes Reef with the multibeam system turned off.

Thursday 07 May 2020

Wind 22 kn from 115°. Sea state 4-5. Low swell.

0800 in position 16.375277°S 147.850535°E in vicinity of Holmes Reefs.

Poor weather overnight required the ship to heave to in the lee of West Holmes Reef. No multibeam data were collected. At 0830, ROV SuBastian was launched for Dive #356 at the northern end of West Holmes Reef, but was recovered soon after because of a technical issue. The next ROV Dive #357 then commenced around 0930 starting at a target depth of 883 m. Through the day, the ROV climbed steadily upwards, at times traversing a prominent exposed rock wall comprised of rock strata, likely coral layers built up through time. Marine life was prevalent among the rock strata with coldwater corals, crinoids and the like clinging to the rock. The ROV traversed through the thermocline around 450 m and entered the lower mesophotic zone. Here we saw soft corals and black corals become more common attached to exposed rock cliffs and boulders. The ROV was recovered at 1600 then commenced a southwest transit towards Flora Reef to collect additional multibeam data around the deeper plateau surface adjacent to the reef.

Friday 08 May 2020

Wind 21 kn from 115°. Sea state 4-5. Low swell.

0800 in position 17.365697°S 148.142091°E in vicinity of Dart Reef.

Through the night *Falkor* mapped around McDermott Reef, a small reef lying between Flora Reef and the Flinders Reefs. Then a transit was made east to try to map an enigmatic seabed feature looking like a long meandering channel incised in the plateau surface over 30 km in length. More mapping was required to find the head of the channel where it drains to the western side of the plateau. From 0900, the vessel made a near pass around the small Dart Reef, then the western side of North Flinders Reef, taking advantage of the daylight to map the shallower upper flanks of this large atoll. From midday, *Falkor* mapped the South Flinders Reef in a clockwise direction. By the end of daylight, *Falkor* had completed one complete circle around South Flinders Reef and then headed up the eastern side of North Flinders Reef.

Saturday 09 May 2020

Wind 15 kn from 105°. Sea state 4. Low swell.

0800 in position 17.503978°S 148.278083°E in vicinity of North Flinders Reef.

The ship continued mapping through the night with winds easing to around 15 kn. A deeper loop commenced around South Flinders Reef, then northward along the western side of North Flinders Reef and then around Dart Reef. The hint of a wave cut platform was detected at ~120 m, possibly indicating maximum sea-level lowstand during previous glacial periods. A similar wave cut terracing had been detected on the adjacent Great Barrier Reef shelf edge. With the improved weather, *Falkor* continued mapping along the eastern North Flinders Reef flanks. Into the evening, the vessel mapped the area between Dart Reef, Heralds Surprise and North Flinders Reef.

Sunday 10 May 2020

Wind 14 kn from 145°. Sea state 4. Low swell.

0800 in position 17.879219°S 148.469603°E in vicinity of South Flinders Reef.

Overnight *Falkor* continued mapping around the outside deeper waters surrounding North Flinders Reef, Heralds Surprise and Dart Reef. Towards the morning, the ship mapped down the western sides of the Flinders Reefs to take up position for ROV Dive #358 on a landslide scarp found on the west side of South Flinders Reef. Dive #358 commenced at 0800 and on the bottom at 1006 m at ~0830 for a livestream. Through the day, the ROV followed a long vertical transect up the ~100 m high face of the scarp, then along the upper flanks and into the lower mesophotic zone. Towards the end of the dive, abundant soft corals and other mesophotic biota were observed, including the overhanging caves around 120 m, again possibly indicating lowstand sea-level positions, causing wave cutting of the limestone rock. The ROV was recovered at 1430 and the vessel commenced mapping of shallow areas on North Flinders Reef during remaining daylight hours.

Monday 11 May 2020

Wind 17 kn from 120°. Sea state 4. Low swell.

0800 in position 17.419672°S 148.921411°E in vicinity of Unnamed 5m Reef.

Through the evening, *Falkor* mapped farther along the incised channel east of Dart Reef on the main plateau surface to find the head of this long channel. The ship then transited towards the Unnamed 5m Reef lying about 30 km east of the Flinders Reefs. Previous LIDAR bathymetry covers this shoal and the vessel mapped throughout the morning around the shallower flanks. By 1300, the Unnamed 5m Reef was completely mapped around the flanks and *Falkor* commenced the transit to Herald Cays in around 880 m depth across the plateau surface. From midday until 1800, the ship mapped the shallower upper flanks around Herald Cays reef, then during the night the deeper flanks of this reef.

Tuesday 12 May 2020

Wind 20 kn from 130°. Sea state 4. Low swell.

0800 in position 16.402862°S 149.165538°E in transit Herald Cays and Moore Reefs.

Falkor completed mapping around the Herald Cays and commenced the ~100 km transit northward to the Moore Reefs, lying northeast of Diane Bank. Around midday, the ship arrived and commenced mapping the three small shallow reefs that comprise Moore Reefs. This area is dotted with strange pinnacles in older mapping data so a systematic survey was commenced at 1600 to broadly map the surrounding plateau and see if these pinnacles are real. Throughout the day, the seafloor revealed a lack of pinnacles and relatively flat, thereby disproving the existence of multiple pinnacles.

Wednesday 13 May 2020

Wind 21 kn from 120°. Sea state 4. Low swell.

0800 in position 16.059367°S 149.137946°E in vicinity of Moore Reefs.

After a night of systematic surveying between the three Moore Reefs, no field of drowned reefs or pinnacles was revealed. The seafloor continued to be relatively flat or with only low scarps of exposed rock on the seafloor. At 0800, with winds easing, *Falkor* left the Moore Reefs and transited towards Diane Bank to map the shallower flanks during daylight hours and while weather was conducive for shallower mapping. *Falkor* arrived at the Diane Bank at 1100 and started an anti-clockwise survey of the shallower flanks.

Thursday 14 May 2020

Wind 21 kn from 125°. Sea state 4-5. Low swell.

0800 in position 15.789163°S 149.602273°E in vicinity of Diane Bank.

Falkor had continued the anti-clockwise mapping of Diane bank through the night, with the weather still quite windy. Depths between Diane Bank and the Willis Islets to the east were around 350 m, quite shallower compared to the previous mapping over the plateau around 1000 m deep. Throughout the morning, the ship continued around the northern then western side of Diane Bank, mapping the shallower flanks during daylight hours. At 1600 the ship at reached the southern side of Diane Bank which revealed possible bedforms on the seafloor. From here, the ship transited towards the Willis Islets, east of Diane Bank.

Friday 15 May 2020

Wind 21 kn from 130°. Sea state 4. Low swell.

0800 in position 16.294416°S 149.984137°E in vicinity of Willis Islets.

Falkor worked in the deeper waters east of Willis Islets overnight, then at daybreak started mapping the shallower flanks near Willis Islets Bureau of Meteorology weather station. The shallower flanks were mapped with multibeam showing undercutting terraces around 100 m depth, indicating possible lowstand sea-level erosion. Through the day, *Falkor* worked into deeper water continuing the anti-clockwise survey around Willis Islets. The seafloor was ~600 m deep and covered in smaller disaggregated blocks lying stranded on the surrounding plateau surface.

Saturday 16 May 2020

Wind 20 kn from 125°. Sea state 4. Low swell.

0800 in position 15.849369°S 149.736014°E in vicinity of Diane Bank.

Overnight, *Falkor* continued mapping anti-clockwise around Diane Bank over the deeper flanks and plateau surrounding the bank. At 1100, the ship commenced east-west lines between the northern side of Diane Bank and the Moore Reefs to understand the low erosional feature between them in about 500 m depth. The systematic survey continued until 1900, revealing ~100 m high cliff faces along this erosional scarp, with superimposed dunes on top. Parts of these platforms have collapsed leaving large blocks stranded at depths ~1000 m. The ship then continued mapping the west side of Diane Bank.

Sunday 17 May 2020

Wind 20 kn from 125°. Sea state 4. Low swell.

0800 in position 16.030018°S 149.070580°E in vicinity of Moore Reefs.

In the early morning, a systematic survey commenced to the southwest of Moore Reefs. At 0800, a new seamount, likely a drowned reef, was discovered rising from 981 to ~370 m, very conical in shape. At 0900, the ship completed the systematic surveying and started the transit to Cairns. Around 1500, *Falkor* had made great progress and commenced mapping the shallower upper flank of East Holmes Reef, revealing a clear steeper zone before a flank filled with smaller gullies. By 1600, the ship continued on towards Cairns.

Monday 18 May 2020

Wind 15 kn from 140°. Sea state 4. Nil swell.

0800 in position 16.842108°S 145.822822°E at anchor near Cairns harbour.

The ship continued transiting across the Queensland Plateau and Queensland Trough towards Cairns. At 0400, the ship entered Grafton Passage and proceeded to the anchorage off Cairns Harbour entrance. At 0800 the ship came to anchor with all multibeam mapping systems turned off.

Tuesday 19 May 2020

Wind 16 kn from 120°. Sea state 4. Nil swell.

0800 in position 16.929636°S 145.779900°E at Cairns wharf.

Falkor remained at anchor overnight, then at 0730 left the anchorage and proceeded into the Cairns wharf, to be alongside by 0800. Crew changeover and reprovisioning occurred throughout the day.

Wednesday 20 May 2020

Wind 16 kn from 120°. Sea state 4. Nil swell.

0800 in position 16.848992°S 145.821052°E at Cairns port anchorage.

Falkor remained at anchor overnight and planned for a crew changeover by boat. At 1200, *Falkor* weighed anchor and departed for the Coral Sea Marine Park through Grafton Passage. The ship commenced surveying with the EM710 multibeam system and mapped across the shelf-break at ~100 m at 1540. Heading easterly, the ship transited across the Queensland

Trough with the EM300 multibeam system and towards the Queensland Plateau. Around 2200, the ship approached the Cairns Seamount mapping along the southern and deeper sides.

Thursday 21 May 2020

Wind 20 kn from 085°. Sea state 4-5. Low swell.

0800 in position 16.570673°S 147.996868°E in vicinity of Holmes Reefs.

Falkor mapped between the Cairns Seamount and Holmes Reefs, filling some mapping gaps around the East Holmes Reef. At 1100, the ship started the transit to the Moore Reefs and Diane Bank area to continue mapping gaps in preparation for the next ROV dive. During the 1100-1200 live Ship2Shore discussion, *Falkor* mapped three small seamounts on the south side of East Holmes Reefs. The largest is 937 m at base, top at 659 m (278 height), with moats around their bases.

Friday 22 May 2020

Wind 13 kn from 110°. Sea state 3. Low swell.

0800 in position 15.882600°S 149.151228°E in vicinity of Moore Reefs.

Overnight, *Falkor* continued mapping around the Moore Reefs trying to determine whether enigmatic seafloor bumps were real seamounts. Only one new seamount was detected, so concluded that these bumps on the previous depth models were likely noise artifacts. The ship positioned itself on the lee side of the northwest Moore Reef and commenced ROV Dive #360 at 0900 and on the seafloor at 944 m. The dive site was chosen to give a complimentary deep dive against an earlier shallow-water survey that revealed high biodiversity in fish and coral life. This deeper dive also found much higher densities of coldwater corals, sponges and fish than we've seen on previous dives. In the mesophotic zone, were also high concentration of softcorals and fish. At 1730 the ROV was recovered and the ship commenced mapping towards the southern Diane Bank.

Saturday 23 May 2020

Wind 20 kn from 170°. Sea state 4. Moderate swell.

0800 in position 16.495350°S 149.706782°E in vicinity of Willis Islets.

Through the night, *Falkor* mapped around the flanks of Diane Bank and Willis Islets, ending up at the southwest side of Willis Islets for ROV dive #361. This dive aimed to confirm whether a

large ~1.4 km long block-like feature lying at ~250 m depth was hard limestone and therefore likely to be the remains of an underwater landslide. At 0830, ROV SuBastian was on the seafloor at 260 m and sand ripples came into view. The dive transited up onto the rock and was clearly hard limestone with a veneer of soft sediments. Patches of softcorals sheltered mesophotic fish species not described. Unfortunately, bad weather terminated the dive and the ROV was recovered at 1000. The ship commenced surveying between Diane Bank and Willis Islets as the weather deteriorated. Extensive dunes were observed lying between these two banks. By nightfall, *Falkor* had rounded the northern side of Willis Islets and headed down the eastern side into the rough seas.

Sunday 24 May 2020

Wind 15 kn from 190°. Sea state 4. Low-Moderate swell.

0800 in position 17.147235°S 149.752565°E in vicinity of Willis Islets.

Falkor transited from the Willis Islets towards the Coringa Islets to the south, and at daybreak, started mapping anti-clockwise around the western and southern side of Coringa Islets reef. Depths were relatively shallow, around 200-300 m with a gentler flank gradient extending to the plateau surface. At 1100, *Falkor* cut across the top of the bank over the lagoon in ~60 m depth, exiting on the northern side at 1200. During the remaining afternoon, the ship surveyed the northern upper flanks of Coringa Islets reef. At 1600, the vessel commenced mapping across the deeper plateau surface around 450 m depth.

Monday 25 May 2020

Wind 17 kn from 170°. Sea state 4. Low-Moderate swell.

0800 in position 16.526272°S 150.302846°E in vicinity of Magdelaine Cays.

Falkor continued mapping along the northern flank of the Coringa Islets towards the Magdelaine Cays reef at the northern end of this large ~80 km long bank. From daybreak, the ship commenced mapping around the Magdelaine Cays reef, identifying a potential ROV site for the next day. Through the morning the ship transited across to the Unnamed 17m Reef about 25 km east of the Magdelaine Cays reef. The ship commenced mapping the shallower upper flanks from 1200 for two laps around this reef. In the evening, the ship transited back to Magdelaine Cays and mapped the southern flank of this large bank.

Tuesday 26 May 2020

Wind 11 kn from 135°. Sea state 3. Low swell.

0800 in position 16.545512°S 150.269814°E in vicinity of Magdelaine Cays.

Falkor mapped the deeper southern flanks of the Magdelaine Cays reef through the night then positioned itself at the northernmost Magdelaine Cay reef for ROV Dive #362. ROV SuBastian entered the water at 0800 and conducted a dive up the southern wall with a start depth of 650 m. The dive concluded at 1330 having seen several live chambered nautilus and numerous seapens in deeper waters. At 1400, the ship departed and transited southwest towards a possible deep channel incised between Willis Islets and the Magdelaine Cays reef.

Wednesday 27 May 2020

Wind 11 kn from 150°. Sea state 3. Low swell.

0800 in position 17.038858°S 149.971757°E in vicinity of Coringa Islets.

Falkor continued mapping the deep channel between Willis Islets and Magdelaine Cays reef through the night, revealing ~30 km long, 700 m wide channel draining towards the northeast. The channel terminated at a series of eroded platforms, appearing like stepped terraces at 908, 935 and 990 m depth. The ship then continued mapping the northern flanks and surrounding plateau of the Magdelaine Cays and Coringa Islets area through the morning. At 1230, the ship passed through the narrow gaps separating the western-most reef from the larger bank. Through the afternoon and evening, the ship mapped around an isolated reef on the southwestern side of Coringa Islets, then continued along the southern deeper flank towards the ROV dive site on the north-eastern tip of Magdelaine Cays reef.

Thursday 28 May 2020

Wind 13 kn from 130°. Sea state 3-4. Low swell.

0800 in position 16.730229°S 150.445021°E in vicinity of Magdelaine Cays reef.

Falkor had mapped the southern flank of Magdelaine Cays reef through the night and positioned itself for a ROV dive on a promontory on the north-eastern point. Unfortunately, technical issues meant the dive was aborted and so the ship continued mapping the northern, deeper flanks of this large bank, heading anti-clockwise around the reef. By 1500, the ship was back in the large embayment at the southern side of the bank while mapping the shallower reef edge missing on previous mapping passes. Towards the evening, the ship passed again across the shallow sandy lagoon where the Knudsen sub-bottom profiler was tested. During the night,

the ship continued mapping gaps within existing coverage along the southern side of Magdelaine Cays reef.

Friday 29 May 2020

Wind 15 kn from 150°. Sea state 3-4. Low swell.

0800 in position 16.725690°S 150.446294°E in vicinity of Magdelaine Cays reef.

Falkor continued mapping the southern margin of the Magdelaine Cays and Coringa Islets reef through the night and morning, filling in gaps within the existing multibeam data coverage. This included more passes around the Unnamed 23 m reef on the south-western side of Coringa Islets reef, then heading north-easterly towards the Unnamed 17 m reef. At 0800, the ship positioned itself at a site on the prominent 'horn' of reef on the northeast corner of Magdelaine Cays reef for ROV dive #363. The start depth was around 571 m and then climbed steadily upwards through the day towards the mesophotic zone in ~100 m depth. The dive completed around 1500 then continued mapping south-westerly towards the Coringa Islets side of the bank, and several laps around the Unnamed 23 m reef at the south-western corner of Coringa Islets reef.

Saturday 30 May 2020

Wind 16 kn from 135°. Sea state 3-4. Low swell.

0800 in position 17.768338°S 150.723981°E in vicinity of Diamond Islets reef.

Overnight, *Falkor* had mapped down the western side of Diamond Islets reef for the first time and then rounded the southern flanks. At 0800, the ship was half way along the southern flank then continued mapping the shallower depths close to the reef edge and then up around the prominent 'horn' of reef jutting out at the northeast side of Diamond Islets reef. Weather conditions were good and so the ship spent the remainder of the day and into the night adding more data coverage to this deeper southern side of the reef. A picture emerged of a very complex seafloor, including numerous gullies, a large canyon and the more familiar debris fields lying along the base of the reef.

Sunday 31 May 2020

Wind 15 kn from 140°. Sea state 3-4. Low swell.

0800 in position 17.901425°S 150.701289°E in vicinity of Diamond Islets reef.

Falkor had continued mapping along the southern margin of Diamond Islets reef, extending farther the extensive mapping coverage over the distinct y-shaped canyon that extended south of the reef. Closer to the reef, a series of prominent steps and ledges appeared. Superimposed on top of the ledges were wide linear 'dunes' extending out across the ledges, each 'dune' seemingly lined up with the 'dune' on the lower ledges. The y-shaped canyon and ledges were decided as targets for the following ROV dives. Then ship continued mapping along this deeper >1000 m seafloor through the night.

Monday 01 June 2020

Wind 14 kn from 145°. Sea state 3-4. Low swell.

0800 in position 17.8421179°S 150.649971°E in vicinity of Diamond Islets reef.

Falkor had continued mapping the southern flanks of Diamond Islets reef to around 14 km away from the edge of the shallow reef. At 0800, the ship positioned itself over the left hand arm of the y-shaped canyon for ROV dive #364 with a start depth of around 935 m in the floor of the canyon. The early part of the dive was over sand with prominent ripples, before a gradual climb up the steeper sides of the canyon to an exposed friable chalky outcrop. The chalky outcrop was filled with small burrows and looked much eroded. A clue to the burrowing was seeing a large isopod inside the burrow and was likely the cause of the larger holes. The dive completed at 1700 and the ship continued mapping the outer flanks of the Diamond Islets through the night.

Tuesday 02 June 2020

Wind 12 kn from 145°. Sea state 3. Low swell.

0800 in position 17.792913°S 150.654080°E in vicinity of Diamond Islets reef.

Falkor had mapped some additional deeper seafloor to the south of Diamond Islets reef overnight, then at 0800 positioned over a site for ROV Dive #365. This site was the companion to the previous dive, with a start depth of 685 m and climbing up a series of steep steps to ledges at 550, 416 and 300 m, before the final climb into the mesophotic depths around 100 m. The dive showed an obvious transition from the coldwater environment, through the thermocline at ~450 m, into the lower mesophotic and upper mesophotic zones. Towards the end of the dive, we saw rhodoliths, then zooxanthellate corals, then *Halimeda* green algae meadows, before recovery at 1700. For the remaining night, the ship continued mapping along

the southern flank of Diamond Islets reef, adding to the impressive mapping data over the complex canyons draining the steeper flanks.

Wednesday 03 June 2020

Wind 25 kn from 135°. Sea state 4-5. Low-Moderate swell.

0800 in position 17.496884°S 150.061359°E in vicinity of Unnamed 22 m reef.

Falkor mapped additional lines along the southern side of Diamond Islets, and then headed along the western steeper flanks, before a short western transit to the Unnamed 22 m reef situated northwest of Diamond Islets. The shallower flanks were mapped on this Unnamed 22 m reef through the evening, then *Falkor* transited back to the Diamond Islets reef and mapped along the northern side of reef. Weather conditions continued to deteriorate but the Diamond Islets reef provided some shelter as the ship headed easterly. The seafloor was generally smooth with occasional clusters of rock debris at base of the flanks.

Thursday 04 June 2020

Wind 25 kn from 135°. Sea state 4-5. Low-Moderate swell.

0800 in position 17.433262°S 151.157990°E in vicinity of Diamond Islets reef.

With the wind still quite high, *Falkor* continued mapping along the northern side of Diamond Islets reef. At 0800, the ship investigated a prominent reef extension on the north-eastern side of Diamond Islets reef in the event of the upcoming World Oceans Day ROV dive, which required a sheltered position. The ship then transited easterly towards Lihou Reef, this largest of all the Queensland Plateau reefs at ~100 km long. Through the day, the ship mapped the shallower flanks on the northern side of Lihou Reef. Depths were around 400 m at the base of the flanks. From 1330 to 1700, the ship hove to on the lee side of Lihou Reef for engine testing, then continued mapping along the deeper flanks through the night.

Friday 05 June 2020

Wind 25 kn from 120°. Sea state 4-5. Low-Moderate swell.

0800 in position 17.326870°S 151.497243°E in vicinity of Lihou Reef.

The windy conditions continued through the night and so *Falkor* remained mapping along the northern side deeper flanks of Lihou Reef. With daylight, the ship headed in a north-easterly direction towards the very eastern tip of Lihou Reef. By 1400, the ship had reached the eastern

side of the mapped area, then turned around heading westerly again, continuing to map farther away from the reef edge and across the deeper surrounding plateau. At 1700 the ship sailed northward away from Lihou Reef then returned back to continue mapping the deeper flanks of Lihou Reef through the night.

Saturday 06 June 2020

Wind 20 kn from 120°. Sea state 4-5. Low-Moderate swell.

0800 in position 17.218074°S 152.141085°E in vicinity of Lihou Reef.

At daybreak, several potential ROV dive sites were visited along the northern Lihou Reef to test current speeds and risk. A potential dive site was chosen over an obvious landslide scarp and with minimal current. At 0900, the ship headed around the eastern point of Lihou Reef into the high winds. The ship then headed in a south-westerly direction along the southern flanks of Lihou Reef mapping a relatively steep wall down to over 800 m. At 1300, a short reverse in direction was made to survey a site identified as highly biodiverse from previous shallow-water surveys at Lihou Reef. A prominent ledge could be seen in the multibeam data around 350 m. The ship then continued mapping in a south-westerly direction, with several reversals to fill in gaps along the deeper flank. At 1800, *Falkor* reached the western limit of Lihou Reef, and because the weather continued to be windy, the mapping continued in a clockwise direction, adding to map data along the northern side.

Sunday 07 June 2020

Wind 20 kn from 115°. Sea state 4. Low-Moderate swell.

0800 in position 17.087801°S 151.913200°E in vicinity of Lihou Reef.

After a night of mapping around the deeper northern flanks of Lihou Reef, the ship positioned near the north-eastern side for ROV dive #366 at a prominent landslide where the entire flank appears collapsed. The ROV entered the water at 0800 for a target depth of 562 m. The dive transited across a debris field and several large blocks, and then across the exposed landslide scarp face. We observed exposed strata or the internal layers of the ancient reef, and the diverse coldwater community and mesophotic marine life attached to these layers. At 1530, the ROV was recovered. Through the night, *Falkor* continued mapping clockwise around the southern side of Lihou Reef.

Monday 08 June 2020

Wind 23 kn from 135°. Sea state 4-5. Low-Moderate swell.

0800 in position 17.490356°S 151.367634°E in vicinity of Lihou Reef.

Falkor continued mapping the southern side of Lihou Reef through the night, then positioned at the north-western side of Lihou Reef for ROV dive #367. This dive commenced at 0800 and had a shallower starting depth of 391 m, then worked towards the reef over prominent debris blocks that had broken off the steeper reef flank. The last part of the dive crossed a relatively gentle gradient, upper flank to about 100 m depth, in search of interesting mesophotic marine life. ROV SuBastian was recovered at 1300 as the wind increased, with the ship then commencing a systematic survey of the area between Lihou Reef and Diamond Islets reef.

Tuesday 09 June 2020

Wind 18 kn from 130°. Sea state 4. Low-Moderate swell.

0800 in position 17.403006°S 151.048388°E in vicinity of Diamond Islets reef.

Falkor did some east-west mapping along the northern side of Diamond Islets reef through the night, then positioned at the north-eastern point for ROV dive #368. The ROV was in the water around 0900 for a World Oceans Day live event recorded to the world, target depth 549 m. The livestream was from 1000-1100 with speakers from around the calling in around their ocean experiences. On conclusion, the ROV dive continued in and around two large blocks of limestone as the remains of an underwater landslide in the long geological past. The dive was generally in depths around 500 m and again lots of nautilus were seen. The ROV was recovered at 1400 and the ship commenced a transit around the southern side of Diamond Islets, trying to minimise the effect of poor weather on the ship.

Wednesday 10 June 2020

Wind 14 kn from 130°. Sea state 4. Low-Moderate swell.

0800 in position 18.150732°S 149.595579°E in vicinity of Abington Reef.

Following a night mapping along the southern side of Diamond Islets reef, *Falkor* transited to Abington Reef bordering the southern Queensland Plateau. Several loops around Abington Reef were completed, then a short transit to Malay Reef, a deeper bank compared to Abington Reef. Several laps around the reef completed the survey at 1430, revealing very steep cliffs on the Townsville Trough side. The ship then commenced the long transit northwest towards the Flora

Reef and Holmes Reefs area with the aim to add additional data to existing multibeam coverage while transiting past the Flinders Reefs area.

Thursday 11 June 2020

Wind 16 kn from 140°. Sea state 4. Low swell.

0800 in position 16.628276°S 147.277562°E in western margin of Queensland Plateau.

Falkor mapped around the eastern side of Flinders Reefs and Heralds Surprise through the night, heading across several anomalous bathymetry spikes in the gbr100 grid. Mapping revealed these to be drowned reefs with heights around 200 m above the surrounding seafloor depth of 1000 m. The ship then continued westerly towards the ROV dive #369 site about 15 km southeast of the Cairns Seamount with a target depth of 1548 m. The site was located at the western limit of the Queensland Plateau, close to the adjoining Queensland Trough, and well away from any coral reefs. The dive investigated some low relief, sculptured seafloor on the plateau surface in depths 1500-1300 m. The dive confirmed the seafloor substrate was mostly hard rock with a veneer of softer sediments on the top. At 1530, the ROV was recovered back onboard. The ship commenced a systematic survey between the Cairns Seamount and Holmes Reefs.

Friday 12 June 2020

Wind 16 kn from 140°. Sea state 4. Low swell.

0800 in position 16.638766°S 146.240979°E in Grafton Passage.

At the conclusion of the systematic surveying between the Cairns Seamount and Holmes Reefs, *Falkor* departed the area around 0100 and commenced transit westerly towards Cairns. The *Falkor* continued mapping while crossing the Queensland Trough, entering Grafton Passage at 0800. *Falkor* came to anchor off Cairns harbour at 1200, concluding the “Visioning of the Coral Sea Marine Park” expedition.